

The Albirupean Formation and its nearest relatives in Maryland.

By P. R. Uhler.

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Near the mouth of the Patapsco river, almost in the path of its ship channel, and at a distance of nearly one mile from the nearest shore of Rock creek, there projects above the surface of the water a huge pile of compact siliceous rock. This conspicuous body of sandstone has been an object of interest to mariners and tourists ever since the entrance to the harbor of Baltimore was first discovered. Almost from the first settlement of the region this island of stone has been called the "White Rocks." This name was given to it because of the white color which it presents when seen from the channel of the river in clear daylight; and the plural term, rocks, has reference to the several masses into which the island has been split by natural agencies. No accurate description of this remarkable object has yet been published, and as it is directly connected with one of the great geological features of Maryland, it deserves to be particularly noticed.

This white quartzite now forms fragments of the great sand-belt which crosses Chesapeake bay from the vicinity of Elkton in Cecil county, and runs in a south-west direction to beyond the great Patuxent river and grades into the low hills before reaching the East branch of the Potomac river. Eleven miles north-north-east of the city of Baltimore, it constitutes an extensive superficial bed, projecting two or three feet above the surface of the sandy loam, exposed over more than half an acre in extent. At this point it is broken into blocks and chunks, is largely composed of pebbly conglomerate (the pebbles often angular in form), and extends down fully ten feet into the sandy loam. South-east of this point for a distance of three miles or more, the same variety of rock has been reached at a depth of twenty to twenty-five feet in the excavations made for wells.

The next point where this quartzite may be seen is about eleven miles farther southeast. There much of the rock has an exceedingly dense texture. It lies in a broad sloping sheet dipping about ten degrees towards the east-south-east, and appears to be about twelve feet in thickness. This sheet of rock runs beneath tidewater at the mouth of Back river, and seems to cover nearly an acre in superficial extent.

About one mile farther to the west and up the Back river a continuation of this bed makes its appearance on the sloping shore.

The rock next appears in North Point creek about five miles farther southward, still maintaining the same compact texture. From this place, however, much of it has been removed, because of its obstruction to navigation.

Three miles distant, across the channel in the Patapsco river, we reach the island of stone alluded to at the beginning.

Here we see three oblong masses of sandstone rock, each more than thirty feet in length, separated by a few feet of water, the more superficial parts of which are a dense quartzite, rising like cliffs ten or twelve feet above high tide, and dipping from twenty to thirty degrees eastwardly. This is not the common dip of the undisturbed members of this series, and probably points to the exercise of tremendous energy in displacing a body of rock more than twenty-five feet thick, which at the bottom of the water, even now, covers more than a square acre in extent.

The two masses lying farthest to the north and east are more generally impregnated with ferric oxide, and being of looser, sandstone texture, suffer more loss of mass from the disintegrating effects of the water and atmosphere.

The most north-eastwardly cliff is exposed to the full force of the storms that beat in from Chesapeake bay, and the heavy ice cakes which are driven by the high winds of early spring plunge with terrific force against this side of the rock and dig out cavities near the water line. The most westwardly of these rocks has been cleft into two great pieces by a longitudinal division, and now lies slanting apart at an angle of about forty-five degrees. These pieces are composed in great part of dense siliceous layers, showing no grain, and weather on the upper surface into figures which resemble large fungi and foliated lichens.

Ferric oxide plays an important part in nearly all the members of this mass, but especially in the more granular and less dense portions. The iron solution stains the siliceous grains, eats into their figure, solders the particles into layers, centres around particular spots, enclosing them with a compact shell, and sometimes develops nodular bodies, such as may be observed in many parts of the sandy region east of Baltimore.

Proceeding from this island to the south-west shore of the Patapsco river we fail at first to find the white quartzite, but instead, there are long and wide stratified beds of brownish sandstone, which run back fifty feet or more in one exposure, and penetrate to an unknown distance into the sandy cliff on the northern shore of Stony creek. This is only a disguised form of our white sandstone which has been almost uniformly stained throughout by the ferric oxide. On the opposite shore directly at the mouth of this same creek there is a deposit of the overlying member of this sandstone series, which originally rested at a higher level than the sandstone beds on the opposite shore. By reason of the eroding energies of tide, frost and ice, this upper bed of coarse ferruginous sandstone has been undermined and thrown upon the bottom of what is now the mouth of the creek. This bed which now lies in water six to ten feet deep, is about twelve feet thick, over seventy feet in length, and perhaps sixteen feet in width.

It is a wonderful piece of structure from the curious way in which it has been altered into long hollow pipes, twisted slabs, and serpentine figures, brilliantly charged with the most intense metallic green, blue, red and yellow tints. How far it extends back into the adjoining country has

not been ascertained, but the unbroken end still sticks out of the adjoining cliff, at an elevation of about six feet above the surface of the water. Broken pieces of this rock lie along the shore in this vicinity extending for more than a mile in each direction from this creek.

On going back into the country, at a distance of five miles, the white sandstone again appears in immense deposits from six to twenty-five feet in thickness, and rests upon the sides or summits of such hills as have been eroded enough to cut down to the level of this stratum. The rock underlies the high hills which stretch across the more south-easterly part of this (Anne Arundel) county, and appears at various places over a low plateau or moderately rolling country, where the sand lies exceptionally deep. South-east of this belt high hills of the greensand Cretaceous form an obstructing barrier across the entire width of the county, and render it difficult of access.

In our Albirupian region, however, we rise gradually upon a moderately elevated plateau, which at its highest point midway between the head of the Severn river and Round bay, reaches scarcely more than eighty feet above the level of the tide.

The country sinks down in the direction of the Patapsco river, but rises as we go across the Magothy to the banks of the Severn and beyond towards the Patuxent.

The next large exposure of the white rock appears near the head of the Magothy river, where it is a massive variable quartzite and sandstone, the under-sides and ends of which disintegrate into sand. In many places only the denser and more compact parts remain as boulders or long masses connected with the sand, which still shows the form and stratification of the original rock; but which crumbles into a shapeless pile wherever it is disturbed. Some parts of the sandstone still retains cores of the hard rock, while the other parts extending to a distance of several rods farther on have undergone a sort of restratification and take on a more level bedding.

From the evidences abundantly present in almost every section of this region, it seems perfectly reasonable to infer that the immense body of sand spreading so widely and extending in such deep beds all over the belt, has been derived from the decay of this sandstone, in connection with the brown sandstone which overlies it, wherever the strata have not been too much disturbed.

After crossing the Severn river but few deposits of the white rock come to view. The sand continues on, but the rock lies deep in the ground, so that only in the wells, or in the deep ravines, do we reach the sandstone, and that is usually the upper and ferruginous member of this series.

However, when we reach the vicinity of the fork of the Great Patuxent river, in Prince George's county, the surface of the country is depressed and on a moderately level tract, almost surrounded by an amphitheatre of hills, the dense white quartzite once more makes its appearance. Here we observe a broken sheet of the rock, more than half a mile in length

by three hundred feet in width, and averaging about three feet in thickness, lying almost horizontal in the soil. At present somewhat more than two square acres of it are exposed to view in an almost continuous stratum. It rests here in a marshy meadow, surrounded by a mixed clayey sand, apparently upon the old flood-bed of the Patuxent river. At this point it is composed of bright, mostly compact silex, of great hardness, but with inconspicuous enclosures of kaolinic material, and closely resembles the common type of Potsdam sandstone. More than an acre of its former mass has been carried away to form abutments on the Baltimore and Potomac railroad.

Here it is more substantial than in the vicinity of the Severn, and seems to suffer but little loss from superficial disintegration. Much of its continuation towards the river has suffered from erosive agencies, and lies, in detached pieces, scattered through the woods. But in that part of the area, it is less densely compacted, and presents the appearance of a coarse-grained sandstone.

Beyond this point, in the direction of the Potomac river, no large exposures of the white rock appear, the Cretaceous sands and clays cover the formation, and it is only in a few of the deepest ravines that we meet with the coarse ferruginous sand-rock which belongs to a higher level in the series.

It yet remains to be seen whether this series of rocky strata is continuous with that which skirts the west shore of the Potomac from Mount Vernon southward to Acquia creek. Such examples of the stone as I have compared with the varieties from Maryland are of a different kind of texture. And, although there are various types of structure ranging all the way from a coarse conglomerate to a perfectly homogeneous quartzite, within our territory, those from Virginia are either composed of more crystalline separate grains, or are more decidedly mixed with drifts of coarse kaolinic matter.

On the Severn river we find excellent sections, giving nearly all the members of the series of strata composing the Albirupear formation. Directly on the river, it occupies a tract of country three and a-half miles wide; but it extends in thin deposits, at intervals between the hills on the northwest, back through a distance of at least ten miles more, thus giving it, in the widest part, a breadth of thirteen and a-half miles. The more rocky portions of this belt occupy now, however, a width of about three miles, and are far from being continuously connected, either along or across their line of strike. But they have not been always so restricted, for in nearly every part of the great sand area, decomposing pieces of the stone with the fresh sand derived therefrom may be found after a short examination of the surface.

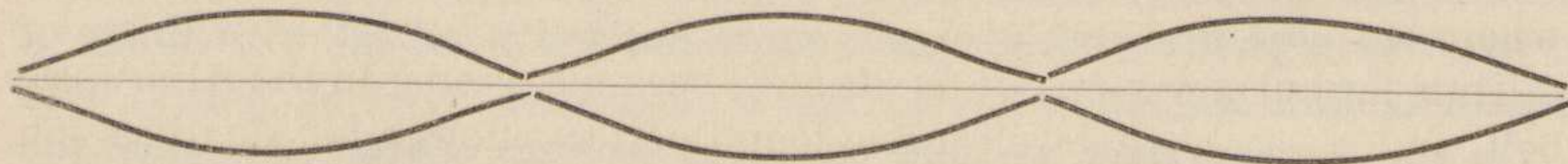
On the eastern shore of Maryland, in Cecil county, the white sandstone appears on the surface in the form of huge boulders, six to ten or more feet in length, and from two to four feet in thickness. Considerable numbers of these large masses project above the surface at intervals on all the

sandy slopes of the lower grounds near the head of the peninsula bounded on the south by the Elk river. The same rock may also be traced in smaller boulders over the surface of the Cretaceous, the Eocene and Miocene to the vicinity of the Choptank river.

In Talbot county, from three to seven miles inland from Easton, it forms a zone of smaller pieces, as if a barrier of drift-loaded ice had stranded in a line across the country there, and melting had dropped these angular pieces in their present position.

The side of the neck of land adjoining the Elk river has been greatly scooped out by superficial agencies, and apparently a large proportion of the sandstone which originally formed the stratum here has been broken up and transported to a distance.

Some of the larger fragments observed on the surface in Talbot county have broad grooves cut diagonally across their surface, as if they had been pushed along under heavy weights which pressed them against sharp edged stones as they were moved over the surface. One piece in particular, four feet in length, nearly three feet in width and almost two feet thick, deserves to be mentioned here, on account of the singular appearance which it presents. It is a nearly flat slab of the very densest and hardest of the quartzite, very difficult to fracture, and resisting to the edge of well-tempered steel. But, notwithstanding its refractory nature, its upper surface composed of dense quartz is mostly polished, and has a series of three acute-ellipsoid excavations, each nearly three inches in length, more than a half inch in depth, and perhaps two-thirds of an inch in width across the middle. The sides of these holes slope towards the middle line and they are connected in a straight series by narrow grooves.



In addition to those, there are two diagonal channels, each about a twelfth of an inch in width cut along through a space of about six inches.

The piece of stone weighs upwards of six hundred pounds and is not like any that the Indians were accustomed to use in the preparation of their food. It was found lying in a field, at a long distance from any habitation, and does not possess any of the features which might accord with the architectural proclivities of any people thus far recognized.

In summing up we find the Albirupean to be a formation composed, as far as our present knowledge extends, of a lower bed of whitish clayey sand of variable thickness (often of five to twelve feet), followed next above by the white sandstone ranging from five to thirty feet in thickness; or where this is replaced by the pure white sand, being as much as ninety feet in thickness. This in turn is overlaid by thirty feet of black, drab,

red or white clay, which in turn grades into sandy clay and sand, from sixteen to thirty feet in thickness; this is overlaid by five to ten feet of ferruginous sand, carrying more or less pebbly, compact quartz, and this in turn is capped by the ferruginous sandstone ranging from two to twenty feet in thickness, over which, more or less, ferruginous sand, pebbles and gritty material, usually only a few feet thick, extends up to the soil of the surface. Accompanying this upper sandstone small and moderately large boulders of all the varieties of our adjacent Archæan rocks, but particularly of the flaky quartz, similar to that from the mica schists, occur, and sometimes form thick beds in the neighborhood of old river or brook channels.

So, by adding together the various members enumerated above, we reach an aggregate of more than two hundred feet for the full thickness of this formation, as we recognize it at the present time.

It rests below the green sand of the Cretaceous, which on the western shore of Maryland is piled up on a ferruginous sand-crust of its own; but the Albirupean has a much steeper average dip than the Cretaceous, and passes unconformably beneath it, as may be seen in the cliffs of the Severn river near Round bay.

The Albirupean dips eastwardly about ten to twelve degrees, while the dip of the Cretaceous scarcely exceeds five or six degrees.

It is nevertheless a fact that abrupt dips occur in all the alluvial formations of our tide-water region, but these appear to be due to the wavy inequalities of the underlying beds in places where material has been heaped up into hillocks by the arrest of rapid, loaded currents of water.

A similar kind of deposition of loose material takes place at the present time, on the bottom of Chesapeake bay and in the mouths of rivers like the Magothy, where "mud lumps," so-called, accumulate at the points where currents of water meet.

Thus far but few kinds of fossils have been discovered in the Albirupean belt, and these have rarely been found perfect enough for identification. Still, we have one species of Brachiopod, stems of Ecrinites and an Annelid-burrow in the white sandstone, and many unidentified vegetable forms in the dark clays which overlie the sandstone.

Such are a few of the features which characterize the Albirupean formation of the State of Maryland. But our sketch would be incomplete if it omitted to notice some of the peculiarities of the great clay-formation which lies beneath the Albirupean. Both together have been united in a common term as forming what has been called the Jurasso-Cretaceous. But whatever their geological position may be in correlation with the European formations, we are now accumulating information enough to show that they have points of difference from those which have been commonly admitted, and to render it necessary to symbolize them by distinct names. It is with this view that the term Albirupean is here proposed for the great sandrock system lying beneath the greensand Cretaceous, and the term Baltimorean for the conspicuous clay formation which

lies near the bottom of the alluvial column on the Archæan rocks of Maryland.

This Baltimorean formation may be recognized in the prominent hills and ridges of variegated red and white, and lead-colored clays which meet the eye near the roads leading along the inner limits of tide-water, between the head of Chesapeake bay, in Cecil county, and the Potomac river, in Washington.

In turning now to the Baltimorean formation, which is especially well-developed within the limits of that city, we see rather abrupt hills, rising eighty to one hundred feet above the adjacent level, composed chiefly of compact clays, alternating with beds of sand, some of which embrace slender drifts of quartz pebbles and fragments of kaolinic clay.

The formation is made up of numerous strata, constituting altogether a column of alluvial matter more than five hundred feet deep. That part which we can examine at or near the level of the lower streets in south Baltimore exhibits a dark lead-colored compact clay, well-stratified, and resting immediately upon a layer of dense iron clay-stone of only a few inches in thickness. Often the clay which comes in direct contact with this stone is stained a bright red color, is of a very fine texture, and is known as "puddling-clay." On this the distinctly stratified layers of dark clay, ranging usually from seven to nine feet in thickness, are built, and consist of strata varying from three inches to fully two feet in thickness. Between the finely ground layers, in contact with the smoothest surfaces, we meet with the remains of trees, shrubs, vines, ferns, equisetæ, and, perhaps, algæ. These fossil remains occur in the greatest profusion, accompanied by finely reduced lignite in the upper strata. At least five such intervening plant-beds are present in the base of Federal hill and its extension eastwards, in each of which some peculiar form of fern, vine, or leaf serves to distinguish it from the others. It has been my good fortune to discover these beds in this region, and to secure ample collections of all the remains at present found in them, and these are now being figured and described by Prof. Fontaine, of Virginia.

From the lowest layer I have taken out plants only of a low type of structure resembling algæ and nitellas; from the next layer above, equisetæ and ferns with strange vine-like structures; from the layer a few feet higher, buds and twigs of trees allied to the cypress and redwoods of California, as also leaves of ferns having the form of those of the Ginko; from the fourth layer other ferns, coniferous stems, buds and scales, with some leaves of dicotyledons resembling sassafras; and from the upper layer leaves which resemble those of the hawthorn, magnolia, willow, and hemlock. The less distinctly stratified clay overlying these is rich in lignite, often containing the trunks and limbs of nearly entire trees, some of which have been found with spruce-like cones and needle-shaped leaves.

The continuation of this bed upwards is composed of the iron-ore clays which form such conspicuous hills and ridges along the road leading to Washington. In this member of the series lie the extensive layers of

carbonate of iron, the richest of which occur near the base, while the nodules and oxidized lumps are found nearer the surface. The extension of this bed still higher, at various levels, displays the red and white variegated clays, such as we see in large areas in crossing the country south and east of the iron-ore hills.

The formation, as far as our present knowledge goes, and disregarding the iron-ore clays, first appears beyond the head of Northeast river on the eastern shore of Maryland, extending thence south of south-west—with an irregular expansion west—down the peninsula between the Northeast and Elk rivers, crossing the Chesapeake bay to Harford county, and proceeding across Baltimore county, the upper half of Anne Arundel and a narrower strip of Howard, Prince George's and Montgomery counties to the Potomac river. It is probably the lowest of the alluvial formations thus far discovered in Maryland resting on the outer, eastward, exposures of the Archæan rocks. Extensive faults in these rocks, besides the erosions, have left deep basins along a wavy line somewhat parallel to the western shores of Chesapeake bay, and in these depressions the beds of the Baltimorean formation have been laid down. At the bottom is found very micaceous sand containing an abundance of that type of compact quartz which belongs to the mica schists, and such as is seen in the Philadelphia micaceous gneiss.*

These micaceous sands form beds in many localities ten feet thick, but oftener much less than that, and they grade almost imperceptibly into obscurely stratified beds of white clay.

Next above this, the white clays alternate with sands in uneven beds, more or less stratified, the sandy members usually carrying drifts of quartz gravel in the lower portion. In some places the clay forms the chief element of these beds, while in others the sands prevail. The entire thickness of this part of the formation ranges from thirty to eighty feet, and is directly overlaid by whitish mixed sandy clay, upon which rests seven to nine feet of a coarse, angular sand, commonly pure white, capped by the thin layer of iron-paint-stone supporting the fossiliferous clay strata and iron-ore beds.

Above these latter the more or less ferruginous sands, mixed with drift of all sizes, form conspicuous beds of very variable thickness. In Clifton reservoir they constitute a series of strata and beds rising thirty feet above the dark or variegated clays, and are overlaid in turn by a few feet of quartz gravel, at or near the surface. Where the clay hills north of Baltimore have been denuded, these gravels are seen at the surface, but where they are undisturbed, the gravel lies from three to ten or more feet below the superficial sand or loam.

The region occupied by this formation is a rolling one, and towards the

* In passing it may be worth while to observe that this variety of gneiss has at one time formed extensive beds in contact with the more basic rocks on the north side of Baltimore, but these have been broken up, and now only their shattered remains rest on, or in, the soil as huge boulders or scattered fragments.

north, north-east and north-west ascends by a series of sloping terraces, each grading seventy feet or more, to a level of about five hundred feet above tide. This is about the highest limit reached by the variegated clays and gravel which can be shown to belong to this formation. North of the city the Baltimorean extends back through the country to a distance of twelve miles, but it does not rise over the tops of the highest hills, and is often interrupted by the ridges of Archæan and other rocks.

Various changes have occurred to the clays of this formation of which a few examples may be cited.

Where cuttings have been made for streets on the north-east side of Baltimore, and at a point about two miles further east, the iron clays have been dislocated, presumably by floods of water, which have transported and dropped them in large lumps, often two or more feet in thickness. These are mixed in huge piles, and in two places have been thrust over the top of the ferruginous sandstone in such a way as to reverse the order of the series.

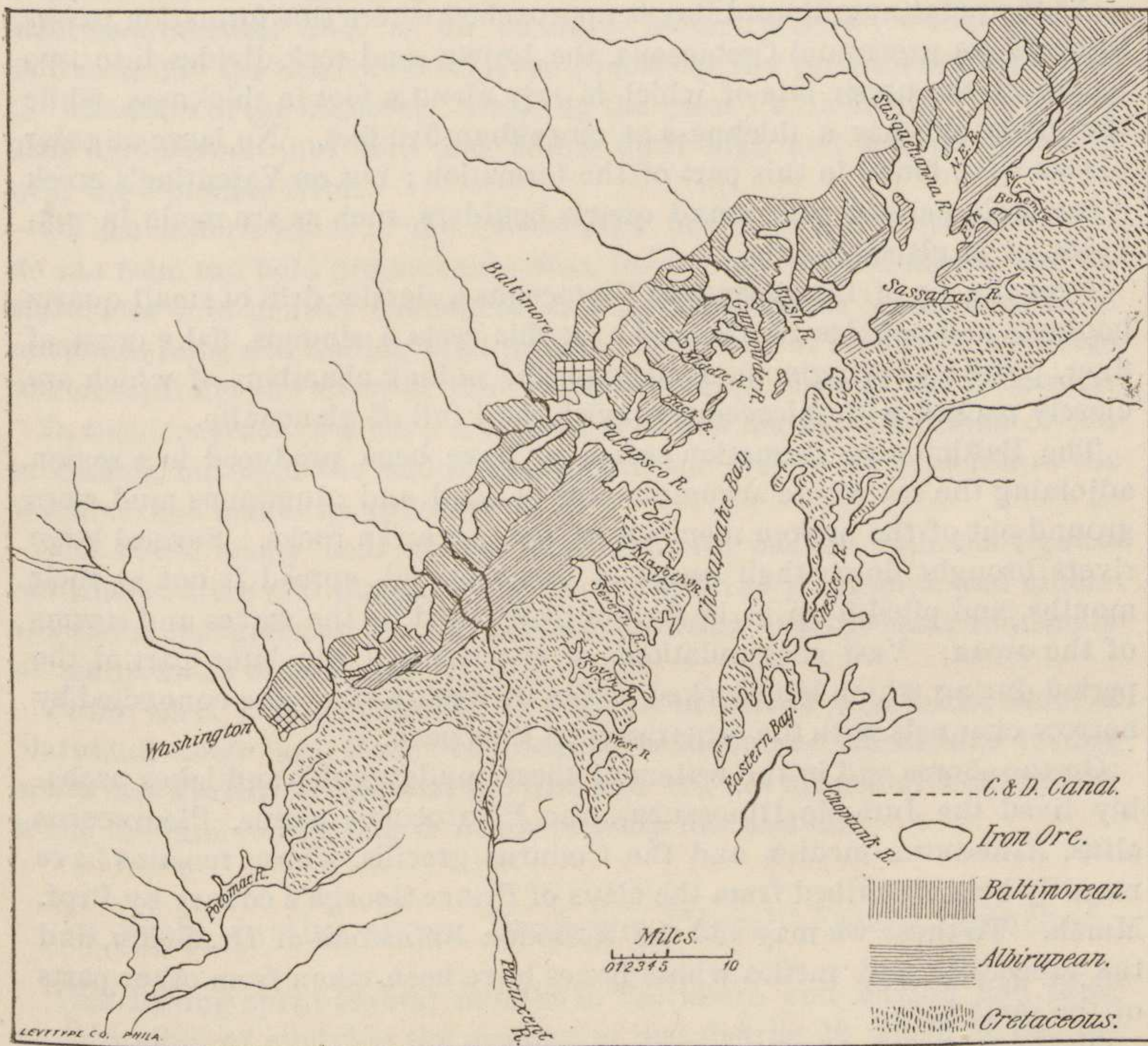
About one mile east of the city, the dark lead-colored clay forms a monumental pile which formerly rose more than eighty feet above the adjoining surface, but it has lost a part of one side by a fault that has produced a downthrow of about seven feet in depth. Another fault, in Federal hill near the end of Warren street, has pushed up the northern end fully seven feet above its proper level. The effects of this dislocation were evident in the broken condition of the beds for about one hundred feet in that direction, while towards the south and south-east there was no break or disturbance in the continuity of the strata.

The red and variegated clays which overlie the iron-bearing member are seen to lie in the hills along the Washington railroad at a much greater elevation than the mixed sandy loam and ferruginous sands which belong above them. This is owing to the fact that in many places the iron-ore series was deeply denuded before the newer beds were laid down; and in some places there are evidences that the next later deposits have been torn off and transported to a distance.

The iron-ore masters insist that the iron-bearing clays rest in detached domes upon the underlying white sand, but this does not correspond with our observations as far as they have gone. We have traced them in a continuous series nearly all the way from the Gunpowder river to the Relay house, a distance of twenty miles, and again on the other side of Elk ridge to near Annapolis junction.

Beneath the city of Baltimore these clays bend down, but have been penetrated or passed through by all the deep wells of the region, and they are found to possess flexures, one of which carries them beneath the middle and eastern branches of the Patapsco river and brings them up on the opposite shores. In the southern continuation of Federal hill they dip down thirty feet in a distance of four blocks, about 1200 feet; but they are discoverable at the bottom of the deep channel of the river and again form hills a mile beyond on the opposite shore. Nine miles south of

Baltimore these strata dip below the surface of tide, pass under the Albirupean at an angle of about twenty degrees and entirely disappear from view.



Reviewing the three alluvial formations which are passed over between the city of Baltimore and Chesapeake bay, we find that each is overlaid by a system of drift, that of the Baltimorean carrying angular erratics, mixed with compact quartz pebbles, all derived from the Archæan rocks of the neighborhood, with the exception only of boulders of Potsdam sandstone probably dropped by floating ice. In the upper part of this mixed gravel, and commonly above it, rests the stratum of ferruginous conglomerate so conspicuous wherever this member of the series occurs.

It is possible that this is the position in the series to which should be referred the thick beds of gravel and quartz drift that now chiefly lie exposed at or next the tops of some of the low hills north of Baltimore.

Near the summit of the Albirupean, we observe loose strata of gravel and quartz-drift, capped by a crust of ferruginous sandrock composed of unusually coarse grains of quartz. This belt of rock is exceedingly thick in some places, as on the Severn river below Indian landing, where it

reaches a thickness of at least twelve feet. The drift in this stratum is chiefly gravel, with small rounded pieces of the compact quartz, and the pebbles usually enter into the composition of the upper part of the brown sand-rock, making it more or less of a pudding stone.

As the point near Round Bay is approached where this formation passes beneath the greensand Cretaceous, the brown sand-rock divides into two members, the upper one of which is only about a foot in thickness, while the lower one has a thickness of more than five feet. No large angular blocks were found in this part of the formation; but on Valentine's creek it is closely packed with round quartz boulders, such as are made in pot-holes, or in glacial rapids.

Near the top of the greensand Cretaceous a slender drift of small quartz boulders and pebbles occurs, and over this rests a sinuous, flaky crust of finer, powdery ferruginous sandstone, the oblong chambers of which are closely packed with micaceous grayish sand full of glauconite.

The Baltimorean formation seems to have been produced in a region adjoining the sea where accumulations of sand and aluminous mud were ground out of the broken members of the Archæan rocks. Several large rivers brought down their quota of this material, spread it out at their mouths, and piled it up to be farther distributed by the waves and storms of the ocean. Vast accumulations of clay marked the later part of the period during which land-locked bodies of fresh water were connected by narrow channels with the estuaries next the ocean.

On the shores and in the waters of these muddy gulfs and lakes probably lived the Jurassic Dinosaur, the *Pleurocœlus nanus*, *Pleurocerus altus*, *Allosaurus medius* and the *Cœlurus gracilis*, whose remains have recently been described from the clays of Prince George's county by Prof. Marsh. To these we may add the *Astrodon Johnstonii* of Dr. Leidy, and the crocodiles and turtles whose bones have been taken from other parts of the same beds.

On the land flourished a richly varied and abundant vegetation, with forests, fern brakes, and trailing vines, while in the rivulets fresh-water plants spread over the bottom of shallow channels.

Following this came the Albirupean, a more decidedly marine formation, in which sands form the chief element of deposition, and which, later, became a distinctly sandstone-forming epoch. Layers of siliceous plastic mud were spread out over the indurated sands and bound them together in heavy belts of stone. Steady deposition, in wide irregular basins, gradually increased the sedimentary beds and quiet periods allowed the development of aquatic animals. Accordingly in the sandstones of this area we find the burrows of worms, the stems of encrinites, the cells of corals and the shells of brachiopods. On the land an ample vegetation must have existed, since between the layers of an upper bed of clay the densely packed lignitic remains of coniferous trees and the fragments of twigs, buds, leaves and seeds of several kinds of plants are found in abundance. On the south-eastern border of this zone of sand and sand-

stone, the greensand Cretaceous rests piled up in high abrupt hills on the western shore of Chesapeake bay, crossing the country with an unevenly defined breadth of about ten miles: On the Severn river, across the southern part of Round Bay, high domes of these clays and loamy sand form monumental hills, as for example Mount Misery; while between this river and the head of South river almost equally prominent hills arrest the attention of the observer. Crossing the great Patuxent the Cretaceous hills again come into view and finally form high and bold prominences near the Potomac river.

On the eastern shore of the Chesapeake, however, the Cretaceous hills do not form the bold prominences that have been noticed above, but instead, rise into gentler eminences, sloping towards the water courses in moderate rolls, and finding their greatest development along the low ridge which separates the rivers of the Chesapeake from those of the Delaware.

In this formation we have a repetition of the marine conditions of the preceding, but with the added element of the greensand, which now for the first time makes its appearance.

The black loamy beds of this formation are packed with the lignitic remains of trees and plants, while the lower lying greensand, and especially the upper greensand marl beds, are crowded with the casts and shells of many kinds of mollusks.

From what is here recorded it will be perceived that in the State of Maryland there are three well-defined sedimentary formations resting below the Tertiaries, and that the first and last are formed of bold reliefs, while the intervening one is comparatively low and flat.

In reply to the above Professor Carvill Lewis remarked:

That having spent several months in Baltimore and having had some opportunities of studying the geology of that district, in which he had the kind assistance of his friend Professor Uhler, he took the liberty of suggesting certain objections to the conclusions of the foregoing paper and to the adoption of the new term "Albirupean."

A series of three formations, belonging to the "alluvial column," is here described, of which the lowest (the "Baltimorean") is a series of variegated clays and sands, some of which have yielded a fauna and flora indicating a Jurassic or Cretaceous age. These have long been known and are marked on Tyson's Geological Map as the "iron-ore clays" and appear to be the formation already named the "Potomac." Upon these clays Professor Uhler places his so-called "Albirupean," consisting sometimes of sands and clays, sometimes of a massive sandstone or quartzite, containing brachiopods, encrinite stems and annelid burrows; while the uppermost of the "three alluvial formations" consists of Cretaceous greensand. This latter is also well known, having been described by Ducatel in 1834.

As to the "Albirupean formation," the speaker held that Professor

Uhler had here confounded under one name two entirely distinct formations of very widely separated ages. The specimen of "Albirupean" exhibited this evening contains fossils (a brachiopod and encrinite stems) characteristic of a Palæozoic and not a Mesozoic formation, and the petrological character of the rock is also that of an ancient sandstone, resembling the Medina or Potsdam sandstones. The fossils point to the lower Silurian age or thereabouts of the sandstone, and it is probably of nearly related age to the metamorphic limestones which occur in the vicinity of Baltimore. It is of course incredible that a rock of Palæozoic age could overlie the "Baltimorean" clays, and Professor Uhler has given no facts or sections to prove that such is the case.

The mistake has probably arisen in confounding the weathered portions of the sandstone with the sands and clays of Mesozoic or more recent age which occasionally overlie the variegated, iron-bearing clays. As a result of decomposition, the ancient sandstone frequently becomes loose and sandy, and is marked with ferruginous streaks so as to closely resemble the much more recent sands and clays of the neighborhood. An example of this kind may be seen a few miles north of Baltimore. The mistake of confounding the two formations would therefore be a very natural one, especially as the younger formation is in large part made out of the older one, and as outcrops in the region are scarce. Geologists cannot be expected to accept the term "Albirupean;" for even if limited on the one hand to the sandbeds of Mesozoic age, or on the other to the patches of Palæozoic quartzite, it is, to say the least, unnecessary, while if applied to both formations it would be a source of confusion.

Professor Heilprin stated that:

From the data and material presented by Dr. Uhler, he was disposed to agree with Professor Lewis that two or more very distinct formations were included in Uhler's "alluvial column," and that one of these (forming part of the so-called "Albirupean" series) was almost unquestionably Palæozoic. At least, this position was indicated by the brachiopod and crinoid impressions which are seen on some of the rock fragments exhibited before the Society. Neither of these impressions is very distinct, but such relationship as they indicate is more nearly with Palæozoic than with Mesozoic forms. Referring to the formations characterized by Dr. Uhler as "Baltimorean" and "Albirupean," and the "Potomac" of the United States Geologists—the last supposed to be in part synchronous with the preceding—and to the determination of their age as Jurassic, Jurasso-Cretaceous, and Lower Cretaceous (Wealden), Professor Heilprin stated that he failed to find any satisfactory evidence proving the strata characterized to be older than Upper Cretaceous, and that in all probability they are the absolute representatives or equivalents of a portion of the well-known New Jersey series—the colored clays and sands abutting upon the Delaware river.